Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

**Bromothymol Blue Cellular Respiration Lab**

Ms. Ottolini, PreAP Biology

**Purpose:**

The purpose of this lab activity is to analyze the affect of exercise on cellular respiration. In this lab, we will identify the role of carbon dioxide production, breathing rate, and heart rate in determining the rate of cellular respiration.

**Background Information:**

Cellular respiration (see chemical reaction below) is a chemical reaction that occurs in your cells to create energy; when you are exercising your muscle cells are creating ATP to contract. Cellular respiration requires oxygen (which is breathed in) and creates carbon dioxide (which is breathed out).

**C6H12O6 + 6 O2 🡪 6CO2 + 6 H2O + 36 ATP (energy)**

This lab will address how exercise (increased muscle activity) affects the rate of cellular respiration. You will measure 3 different indicators of cellular respiration: breathing rate, heart rate, and carbon dioxide production. You will measure these indicators at rest (with no exercise) and after 2 minutes of exercise. Breathing rate is measured in breaths per minute, heart rate in beats per minute, and carbon dioxide in the time it takes bromthymol blue to change color.

Carbon dioxide production can be measured by breathing through a straw into a solution of bromthymol blue (BTB). BTB is an acid indicator; when it reacts with acid it turns from blue to yellow. When carbon dioxide reacts with water, a weak acid (carbonic acid) is formed. The more carbon dioxide you breathe into the BTB solution, the faster it will change color to yellow.

**Materials:**

Test tube

bromthymol blue solution (BTB)

straw

stop watch / cell phone timer

**Pre-Lab:** Use your background information and your Cellular Respiration Guided Reading to answer the following pre-lab questions.

1. What are the reactants and products of cellular respiration?

2. In what part of the cell does cellular respiration occur?

3. Write a prediction/hypothesis of how exercise will affect your body’s production of carbon dioxide (i.e. do you think your body will produce more or less carbon dioxide as you exercise). Make sure you explain your prediction based on your knowledge of cellular respiration.

**Procedure:**

**Part A: Resting (no exercise)**

***Measuring Carbon Dioxide Production:***

1. Use a graduated cylinder to measure out 10 mL of tap water and pour it into a test tube.

2. Use a dropper to add 15 drops of bromthymol blue solution.

3. Using a straw, exhale into the BTB solution. (CAUTION: Do not inhale the solution!)

4. Time how long it takes for the blue solution to turn yellow for each student in your lab group. Use the same test tube and wash it out after each trial.

***Measuring Breathing Rate:***

1. Count the number of breaths (1 breath = inhale + exhale) you take in 1 minute. Repeat for each of your group members

***Measuring Heart Rate:***

1. While you calculate your breathing rate, take your pulse by placing two fingers on the side of your neck.

2. Count the number of beats in 30 seconds and multiply that number by 2. Repeat for each of your group members.

**Part B: After Exercise**

Run up and down the stairs from the third floor to the first floor twice. Take the same three measurements you recorded before exercising after you finish running.

**Data Tables:**

**Resting**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measurement** | **Group Member 1** | **Group Member 2** | **Group Member 3** | **Group Average** | **Class Average** |
| CO2 production (time it takes to turn yellow) |  |  |  |  |  |
| Breathing Rate (breaths per minute) |  |  |  |  |  |
| Heart Rate (beats per minute) |  |  |  |  |  |

**After Exercise**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measurement** | **Group Member 1** | **Group Member 2** | **Group Member 3** | **Group Average** | **Class Average** |
| CO2 production (time it takes to turn yellow) |  |  |  |  |  |
| Breathing Rate (breaths per minute) |  |  |  |  |  |
| Heart Rate (beats per minute) |  |  |  |  |  |

**Analysis Questions:**

Answer the following analysis questions in preparation for writing your three conclusion paragraphs. You will not be graded on your answers to these questions, but answering them will help you to write clear, concise conclusion paragraphs.

1. How did exercise affect the time needed for the solution to change color? Explain why the color change occurred (How does BTB work?)

2. What can you conclude about the effect of exercise on the amount of carbon dioxide that is present in your exhaled breath? Why is this so?

3. What can you conclude about the effect of exercise on breathing rate? Why is this so?

4. What can you conclude about the effect of exercise on heart rate? Why is this so? What do your muscles need during exercise that the blood brings?

5. State whether your hypothesis was correct or incorrect and why. In doing so, discuss what you think is going on in the muscles of the body as muscle activity is increased. Address the need to get oxygen to the muscles and get rid of carbon dioxide, as well as how the muscles cells get the energy needed to continue contracting.

**Conclusion Paragraphs:**

***Expectations:***

Paragraph #1: REE – Results with Evidence and Explanation

1. Results – Explain how the goals/purpose of the lab were/were not achieved.
2. Evidence – Support answers with numerical data.
3. Explanation – Do the data support or not support (refute) hypothesis?

Paragraph #2: PE – Possible Errors (must have at least 2)

1. Explain experimental design errors that would lead to false data.
2. Recommendations on how to improve the experiment to minimize the error.

Paragraph #3: PA – Practical Applications

1. What have you learned? (this must relate to the results of the experiment)
2. Recommendations for follow up experiments.

***Rubric:***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | | **Excellent (5 points)** | **Good (3 points)** | **Needs Improvement (1 point)** |
| **Conclusion** | **A) Results**  **Evidence**  **Explanations** | * Conclusion begins with a clear, concise discussion of the purpose of the experiment or study. * All of the important results are explained in relation to the purpose statement. * The results statement includes (numerical) evidence (including averages) when appropriate. * A clear and concise explanation of how the data supports or refutes expectations or hypotheses is given. | * The purpose of the experiment or study is mentioned but is not clear, concise, and accurate. * Most of the important results are explained in relation to the purpose statement. * The results statement includes evidence that is not numerical when needed. * Some explanation of results is given but no mention of how the data supports or refutes expectations or hypotheses. | * There is no mention of the purpose or the subject of the study. * The results of the experiment or study are not stated. * Little evidence is given for the results of the experiment. * Little explanation of whether the data supports or refutes expectations or hypotheses is given. |
| **B) Possible Errors** | At least two examples of procedural errors or uncertainties that could lead to inaccurate data are identified and explained. Discuss ways to avoid these errors in the future. | Examples of procedural errors or uncertainties are identified but no discussion of ways to avoid these errors. | Unclear examples of procedural errors or uncertainties that could lead to inaccurate data are identified and explained. |
| **C) Practical Applications** | A clear, concise explanation what you learned in this lab (must be related to the RESULTS of the experiment!), and recommendations for follow-up experiments. | An explanation lacking one of the following:  1. What you learned in this lab  2. Recommendations for follow-up experiments | An explanation lacking both of the following:  1. What you learned in this lab  2. Recommendations for follow-up experiments, |